

# ANOVA Checkpoint

## Question (1)

For which of the following would it be most appropriate to use an ANOVA to analyze the data?

**A:** A researcher is interested in determining the most effective format for advertising. He randomly assigns 60 people to one of three groups: (1) television commercial, (2) radio commercial, or (3) magazine advertisement. Group members review the commercial and then report whether or not they would buy the product.

**B:** In order to determine the effectiveness of different diet plans, 90 people are randomly assigned to one of three groups: 1) low calorie diet, 2) low-fat diet, or 3) low-carb diet. At the end of 60 days, the number of pounds lost was recorded for each of the participants.


**C:** Both A and B.

**D:** Neither A nor B.


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### Feedback


**A : 0**

 That's incorrect. While there is a categorical explanatory variable, with more than 2 categories, the response variable is categorical (Yes, would buy the product/No, would not buy the product). The ANOVA is an example of Case C→Q, where there is a categorical explanatory variable and quantitative response variable. The correct answer is B.

**B : 10**

 That is Correct! There is a categorical explanatory variable (type of diet), with more than two categories, and a quantitative response variable (number of pounds lost).

**C : 0**

 That's incorrect. While it would be appropriate to use the

**X** ANOVA for B, it would not be appropriate to use the ANOVA for A. While A does have a categorical explanatory variable, with more than 2 categories, the response variable is categorical (Yes, would buy the product/No, would not buy the product). The ANOVA is an example of Case C?Q, where there is a categorical explanatory variable, with more than two categories, and quantitative response variable. The correct answer is B.

**D : 0**

**X** That's incorrect. While it would not be appropriate to use the ANOVA for A, it would be appropriate to use it for B. In B, there is a categorical explanatory variable (type of diet), with more than two categories, and a quantitative response variable (number of pounds lost). The correct answer is B.

Please use the following information for Questions 2, 3, and 4.

To determine whether there is a relationship between the type of school attended and verbal reasoning scores for Irish students, three samples with 25 students, in each group, were randomly selected from data used by Raftery and Hout (1985). One group of students attended secondary school. The second group of students attended vocational school. And, the third group, consisted of students, who attended only primary school.

*Raftery, A.E. and Hout, M. (1985). Does Irish education approach the meritocratic ideal? A logistic analysis.*

*Economic and Social Review, 16, 115-140.*

## Question (2)

If we let  $\mu_1$ ,  $\mu_2$ , and  $\mu_3$  be the mean verbal reasoning scores for students who attended secondary school, vocational school, and primary school only, respectively, the appropriate hypotheses in this case are:

If we let  $\mu_1$ ,  $\mu_2$ , and  $\mu_3$  be the mean verbal reasoning scores for students who attended secondary school, vocational school, and

primary school only, respectively, the appropriate hypotheses in this case are:

**A:**

$$H_0: \mu_1 = \mu_2 = \mu_3$$

$H_a: \mu_1, \mu_2, \mu_3$ , are not all equal

**B:**

$H_0: \mu_1, \mu_2, \mu_3$ , are not all equal

$$H_a: \mu_1 = \mu_2 = \mu_3$$

**C:**

$$H_0: \mu_1 = \mu_2 = \mu_3$$

$$H_a: \mu_1 \neq \mu_2 \neq \mu_3$$

**D:**

$$H_0: \mu_1 \neq \mu_2 \neq \mu_3$$

$$H_a: \mu_1 = \mu_2 = \mu_3$$

**E:** None of the above are correct.

**A : 10**

✓ Correct! The alternative hypothesis for the ANOVA is not all the  $\mu$ 's are equal.

**B : 0**

✗ That is incorrect. It looks like you reversed the null and alternative hypotheses. Remember, the null hypothesis is always no differences, while the alternative hypotheses for the ANOVA is not all the  $\mu$ 's are equal. Consider the remaining options. The correct answer is A.

**C : 0**

✗ That is incorrect. Remember, we want to know if there is sufficient evidence to conclude that not all three groups had the same verbal reasoning scores. However, this would still allow two groups to score equally well, while a third group did better or worse. Consider the remaining options. The correct answer is A.

**D : 0**

**X** That is incorrect. First, it looks like you reversed the null and alternative hypotheses. Remember, the null hypothesis is always no differences, while the alternative hypotheses for the ANOVA is not all the  $\mu$  are equal. In addition, for the alternative hypothesis, we want to know if there is sufficient evidence to conclude that not all three groups had the same verbal reasoning scores. The correct answer is A.

**E : 0**

**X** That is incorrect. The null hypothesis is always no differences, while the alternative hypotheses for the ANOVA is not all the  $\mu$ 's are equal. Consider the remaining options. The correct answer is A.

## Question (3)

Here are the three sample standard deviations for the verbal reasoning scores for the three groups (secondary school, vocational school, and primary school only):

Column	Std. Dev.
Secondary School	13.994021
Vocational School	14.1778755
Primary School Only	11.713036

Based on this information, do the data meet the condition of equal population standard deviations for the use of the ANOVA?

**A:** Yes, because  $14.18 - 11.71 < 2$

**B:** Yes, because  $14.18/11.71 < 2$

**C:** No, because the standard deviations are not equal

**D:** Unable to determine from the information provided

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### Feedback

**A : 0**





That is incorrect. The condition of equal population standard deviations is considered to be met if the *ratio* of the largest sample standard deviation to the smallest sample standard deviation is less than 2. The correct answer is B.

**B : 10**



Correct! The condition of equal population standard deviations is considered to be met if the *ratio* of the largest sample standard deviation to the smallest sample standard deviation is less than 2.

**C : 0**



That is incorrect. The condition of equal population standard deviations is considered to be met if the *ratio* of the largest sample standard deviation to the smallest sample standard deviation is less than 2. The correct answer is B.

**D : 0**



That is incorrect. The condition of equal population standard deviations is considered to be met if the *ratio* of the largest sample standard deviation to the smallest sample standard deviation is less than 2. The correct answer is B.

## Question (4)

The analysis was run on the data and the following output was obtained:

ANOVA table

Source	df	SS	MS	F-Stat	P-value
Treatments	2	11040.507	5520.2534	41.361916	<0.0001
Error	72	9609.28	133.46222		
Total	74	20649.787			

Based on this information, we :

**A:** Fail to reject the  $H_0$  and conclude that the data provide strong evidence that the three mean verbal reasoning scores (representing the three types of schools attended) are not all equal.

**B:** Fail to reject the  $H_0$  and conclude that the data do not provide sufficient evidence that there is a relationship between the type of school attended and verbal reasoning scores for Irish students.

**C:** Reject the  $H_0$  and conclude that the data provide strong evidence that there is a relationship between the type of school attended and verbal reasoning scores for Irish students.

**D:** Reject the  $H_0$  and conclude that the data provide strong evidence that verbal reasoning scores are related to type of school in the following way: the mean verbal reasoning score for Irish students who attended secondary school is higher than the mean verbal reasoning score for Irish students who attended vocational school, which in turn is higher than that of Irish students who attended only primary school.

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### Feedback

**A : 0**

**X** That is incorrect. While the conclusion is correct, since the p-value is less than .0001, we would reject the null hypothesis. The correct answer is C.

**B : 0**

**X** That is incorrect. Since the p-value is less than .0001, we would reject the null hypothesis; as a result, we would conclude that there is enough evidence to suggest that there is a relationship between the type of school attended and verbal reasoning scores for Irish students. The correct answer is C.

**C : 10**

✓ Correct! Since the p-value is less than .0001, we would reject the null hypothesis and, as a result, would conclude that there is enough evidence to suggest that there is a relationship between the type of school attended and verbal reasoning scores for Irish students.

**D : 0**

✗ That's not quite correct. While we would reject that  $H_0$ , we would conclude that there is enough evidence to suggest that there is a relationship between the type of school attended and verbal reasoning scores for Irish students. It is not possible, based on the information provided, to determine how the groups differ from one another. The correct answer is C.

*[Raftery, A.E. and Hout, M. \(1985\). Does Irish education approach the meritocratic ideal? A logistic analysis.](#)*

*[Economic and Social Review, 16, 115-140.](#)*